The present invention is based on the above technological concept and the gist of the present invention is as follows:

(1) A high strength steel sheet excellent in formability, chemical converted coating treatment and hot-dip galvanizing, characterized in that: said steel sheet contains, in mass,

0.03 to 0.20% C,
0.005 to 0.3% Si,
1.0 to 3.1% Mn,
0.001 to 0.06% P,
0.001 to 0.01% S,
0.0005 to 0.01% N,
0.2 to 1.2% Al, and
not more than 0.5% Mo,

with the balance consisting of Fe and unavoidable impurities; the amounts of Si and Al in mass % and the target strength (TS) of said steel sheet satisfy the following expression (1); and the metallographic structure of said steel sheet contains ferrite and martensite;

$$(0.0012 \times [\text{target strength TS}] - 0.29 - [\text{Si}])/2.45 < \text{Al} < 1.5 - 3 \times [\text{Si}] \quad \ldots\ (1)$$

where, [target strength TS] is the designed strength of said steel sheet in terms of MPa and [Si] is the amount of Si in terms of mass %.

(2) A high strength steel sheet excellent in formability, chemical converted coating treatment and hot-dip galvanizing according to the item (1), characterized by further containing, in mass, one or more of 0.01 to 0.1% V, 0.01 to 0.1% Ti and 0.005 to 0.05% Nb.

(3) A high strength steel sheet excellent in formability, chemical converted treatment and hot-dip galvanizing according to the item (1) or (2),

characterized by: further containing 0.0005 to 0.002 mass % B; and satisfying the following expression (2),

$$500 \times [B] + [Mn] + 0.2[Al] < 2.9 \quad \ldots\ (2)$$

where, [B] is the amount of B, [Mn] that of Mn, and [Al] that of Al, each in terms of mass %.

(4) A high strength steel sheet excellent in formability, chemical converted treatment and hot-dip galvanizing according to any one of the items (1) to (3), characterized by further containing, in mass, one or both of 0.0005 to 0.005% Ca and 0.0005 to 0.005% REM.

(5) A high strength steel sheet excellent in formability, chemical converted coating treatment and hot-dip galvanizing, characterized in that ferrite grains, wherein the ratio of the breadth to the length of each said ferrite grain is 0.2 or more, account for not less than 50% of the total ferrite grains in said high strength steel sheet according to any one of the items (1) to (4).

(6) A high strength steel sheet excellent in formability, chemical converted treatment and hot-dip galvanizing according to any one of the items (1) to (5), characterized in that said steel sheet is a hot-rolled steel sheet or a cold-rolled steel sheet.

(7) A high strength steel sheet excellent in formability, chemical converted treatment and hot-dip galvanizing according to any one of the items (1) to (6), characterized in that hot-dip galvanizing treatment is applied to said steel sheet.

(8) A method for producing a high strength steel sheet excellent in formability, chemical converted treatment and hot-dip galvanizing according to any one of the items (1) to (7), characterized in that said steel sheet is produced through the processes of: hot rolling at a finishing temperature of the Ar_3 transformation

temperature or higher; coiling at 400°C to 550°C; successively applying ordinary pickling; thereafter primary cold rolling at a reduction ratio of 30 to 70%; then recrystallization annealing in a continuous annealing process; and successively skin-pass rolling.

(9) A method for producing a high strength steel sheet excellent in formability, chemical converted treatment and hot-dip galvanizing according to the item (8), characterized in that, in said annealing process, said steel sheet is: heated to a temperature in the range from the Ac_1 transformation temperature to the Ac_3 transformation temperature + 100°C; retained for 30 sec. to 30 min.; and thereafter cooled to a temperature range of 600°C or lower at a cooling rate of not less than X °C/sec., X satisfying the following expression (3),

$$X \geqq (Ac_3 - 500)/10^a \quad \ldots\ (3)$$

$$a = 0.6[C] + 1.4[Mn] + 3.7[Mo] - 0.87,$$

where, X is a cooling rate in terms of °C/sec., Ac_3 is expressed in terms of °C, [C] is the amount of C, [Mn] that of Mn, and [Mo] that of Mo, each in terms of mass %.

Brief Description of the Drawings

Figure 1 is a graph showing the ranges of Al and Si for each target strength TS.

Figure 2 (a) is a graph showing the relationship between the performance of chemical conversion treatment and hot-dip galvanization and the amounts of Mn and B in the case of 0.4% Al, and Figure 2 (b) is a graph showing the relationship between the performance of chemical conversion treatment and hot-dip galvanization and the amounts of Mn and B in the case of 1.2% Al.

Figure 3 is a graph showing the relationship between the cooling rate for securing ductility and the chemical components.

Best Mode for Carrying out the Invention

The embodiments of the present invention will be hereunder explained in detail.

Firstly, the reasons for regulating the chemical components and the metallographic structure of a high strength steel sheet according to the present invention will be explained.

CLAIMS

1. (Amended) A high strength steel sheet excellent in formability, chemical converted coating treatment and hot-dip galvanizing, characterized in that: said steel sheet contains, in mass,

0.03 to 0.20% C,
0.005 to 0.3% Si,
1.0 to 3.1% Mn,
0.001 to 0.06% P,
0.001 to 0.01% S,
0.0005 to 0.01% N,
0.2 to 1.2% Al, and
not more than 0.5% Mo,

with the balance consisting of Fe and unavoidable impurities; the amounts of Si and Al in mass % and the target strength (TS) of said steel sheet satisfy the following expression (1); and the metallographic structure of said steel sheet contains ferrite and martensite;

$$(0.0012 \times [\text{target strength TS}] - 0.29 - [\text{Si}])/2.45 < \text{Al} < 1.5 - 3 \times [\text{Si}] \quad \ldots\ (1)$$

where, [target strength TS] is the designed strength of said steel sheet in terms of MPa and [Si] is the amount of Si in terms of mass %.

2. (Amended) A high strength steel sheet excellent in formability, chemical converted treatment and hot-dip galvanizing according to claim 1, characterized by further containing, in mass, one or more of 0.01 to 0.1% V, 0.01 to 0.1% Ti and 0.005 to 0.05% Nb.

3. (Amended) A high strength steel sheet excellent in formability, chemical converted treatment and hot-dip galvanizing according to claim 1 or 2, characterized by: further containing 0.0005 to 0.002 mass % B; and satisfying the following expression (2),

$$500 \times [\text{B}] + [\text{Mn}] + 0.2[\text{Al}] < 2.9 \quad \ldots\ (2)$$

where, [B] is the amount of B, [Mn] that of Mn, and [Al]

that of Al, each in terms of mass %.

4. (Amended) A high strength steel sheet excellent in formability, chemical converted treatment and hot-dip galvanizing according to any

one of claims 1 to 3, characterized by further containing, in mass, one or both of 0.0005 to 0.005% Ca and 0.0005 to 0.005% REM.

5. (Amended) A high strength steel sheet excellent in formability, chemical converted coating treatment and hot-dip galvanizing, characterized in that the ferrite grains, wherein the ratio of the breadth to the length of each ferrite grain is 0.2 or more, account for not less than 50% of the total ferrite grains in said high strength steel sheet according to any one of claims 1 to 4.

6. (Amended) A high strength steel sheet excellent in formability, chemical converted treatment and hot-dip galvanizing according to any one of claims 1 to 5, characterized in that said steel sheet is a hot-rolled steel sheet or a cold-rolled steel sheet.

7. (Amended) A high strength steel sheet excellent in formability, chemical converted treatment and hot-dip galvanizing according to any one of claims 1 to 6, characterized in that hot-dip galvanizing treatment is applied to said steel sheet.

8. (Amended) A method for producing a high strength steel sheet excellent in formability, chemical converted treatment and hot-dip galvanizing according to any one of claims 1 to 7, characterized in that said steel sheet is produced through the processes of: hot rolling at a finishing temperature of the Ar_3 transformation temperature or higher; coiling at 400°C to 550°C; successively applying ordinary pickling; thereafter primary cold rolling at a reduction ratio of 30 to 70%; then recrystallization annealing in a continuous annealing process; and successively skin-pass rolling.

9. (Amended) A method for producing a high strength steel sheet excellent in formability, chemical converted treatment and hot-dip galvanizing according to claim 8, characterized in that, in said annealing

process, said steel sheet is: heated to a temperature in the range from the Ac_1 transformation temperature to the Ac_3 transformation temperature + 100°C; retained for 30 sec. to 30 min.; and thereafter cooled to a temperature range of 600°C or lower at a cooling rate of not less than X °C/sec., X satisfying the following expression (3),

$$X \geqq (Ac_3 - 500)/10^a \quad \ldots\ (3)$$

$$a = 0.6[C] + 1.4[Mn] + 3.7[Mo] - 0.87,$$

where, X is a cooling rate in terms of °C/sec., Ac_3 is expressed in terms of °C, [C] is the amount of C, [Mn] that of Mn, and [Mo] that of Mo, each in terms of mass %.